

Remarks

Claims 80, 97, 104, 113, 124 and 138 have been amended. Claims 85, 89, 99, 107, 114, 115, 121, 129, 130 and 134 have been cancelled.

Objections to Disclosure

The Examiner has requested that the Applicants renumber the pages and figures of the specification consecutively and to amend the specification to remove all references to Figs. 6 and 7.

However, Applicants have enclosed herewith Figs. 6 and 7 for incorporation into the specification and request entry thereof. The prior application (U.S. Patent Application Serial No. 09/141,405) of which the present application is a divisional application, was fully incorporated by reference into the present application at page 2 of the application transmittal filed on December 29, 2000.

“...an applicant may incorporate by reference the prior application by including, in the continuation or divisional application-as-filed, a statement that such specifically enumerated prior application or applications are “hereby incorporated herein by reference.” The statement may appear in the specification or in the application transmittal letter.” (MPEP 201.06(c), pp. 200-36 to 200-37)

Figs. 6 and 7 attached hereto are identical to Figs. 6 and 7 from the prior application. No new matter has been added. Therefore, Applicants request entry of these figures and removal of the Examiner's objection to the specification.

The Examiner has also objected to the disclosure due to certain informalities at page 74, line 4 and page 60, line 15. The Examiner has also requested clarification regarding the compound $Y_3(Ga,Al)_5O_{12}$ (pages 47 and 48). Applicants have amended the specification accordingly.

Objections to Claims

The Examiner has objected to Claim 121 as being of improper dependent form since it does not further limit independent Claim 113. Therefore, Claim 121 has been cancelled.

Claim Rejections - 35 USC §112

The Examiner has rejected Claims 82-84, 87 and 97-142 under 35 USC §112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors, at the time the application was filed, had possession of the claimed invention. Applicants have amended the claims and the specification accordingly and removal of this rejection is requested.

The Examiner has rejected Claims 89 and 134 under 35 USC §112, second paragraph, as being indefinite with respect to the compound $Y_3(Ga,Al)_5O_{12}$. Applicants have amended the specification and the claims have been cancelled. Accordingly, removal of this rejection is requested.

Claim Rejections – Ohno et al.

The Examiner has rejected Claims 80, 81, 83-85, 93, 96, 104-107, 109, 111, 124, 129, 130, 135 and 136 under 35 USC §102(b) as being anticipated by US Patent No. 4,801,398 by Ohno et al. In view of the foregoing amendments, Applicants traverse this rejection.

Ohno et al. is directed solely to yttria phosphors (Y_2O_3) and does not disclose or suggest other phosphor compounds. Independent Claims 80, 104 and 124 have been amended to specify the phosphor compounds and remove the inclusion of Y_2O_3 . Therefore, removal of this rejection is requested.

Claim Rejections – Yamanoi et al.

The Examiner has rejected Claims 80, 83, 84, 89, 93, 94, 96, 104-106, 109-111, 124, 134, 136, 138 and 142 under 35 USC §102(b) as being anticipated by US Patent No. 5,037,577 by Yamanoi et al. Further, the Examiner has rejected Claims 81 and 135 under 35 USC §103 as being obvious in view of Yamanoi et al. In view of the foregoing amendments, Applicants respectfully traverse this rejection.

Yamanoi et al. disclose $Y_3Al_5O_{12}$ (YAG) particles utilized in a CRT device. It is alleged that the particles are spherical with an average size of 0.2 to 5 μm .

Independent Claim 80 has been amended to recite that the cathodoluminescent phosphor particles for the device are selected from the group consisting of $\text{Y}_2\text{O}_2\text{S}$, ZnS , Zn_2SiO_4 , SrGa_2S_4 and Y_2SiO_5 . Yamanoi et al. do not disclose or suggest phosphor particles having the foregoing compositions. Therefore, removal of this rejection with respect to Claim 80 is requested. Claims 83 and 84 depend on Claim 80. Claim 89 has been cancelled. Claims 93, 94 and 96 also depend on Claim 80. Therefore, removal of this rejection with respect to these claims is also requested.

Independent Claim 104 has been amended to recite that the cathodoluminescent display device includes a layer of Zn_2SiO_4 phosphor particles. Yamanoi et al. do not disclose or suggest zinc silicate phosphor particles. Claims 105, 106 and 109-111 depend upon Claim 104 and include all of the limitations thereof. Therefore, removal of this rejection with respect to these claims is respectfully requested.

Independent Claim 124 has been amended to recite that the cathodoluminescent phosphor particles are selected from the group consisting of $\text{Y}_2\text{O}_2\text{S}$, ZnS , SrGa_2S_4 and Y_2SiO_5 . Yamanoi et al. do not disclose or suggest any of these phosphor compounds. Claim 134 has been cancelled. Claim 136 depends upon Claim 124 and includes all of the limitations thereof. Therefore, removal of this rejection with respect to Claims 124, 134 and 136 is requested.

Independent Claim 138 has been amended to recite that the phosphor particles are selected from the group consisting of Y_2O_3 , $\text{Y}_2\text{O}_2\text{S}$ and Zn_2SiO_4 . Yamanoi et al. do not disclose or suggest these phosphor compounds. Claim 142 depends upon Claim 138 and includes all of the limitations thereof. Therefore, removal of this rejection with respect to Claims 138 and 142 is requested.

The Examiner has rejected Claims 80, 83, 84, 93, 104, 106 and 109 under 35 U.S.C. 102(b) as being anticipated by U.S. Patent No. 3,778,540 by Shidlovsky. The Examiner has also rejected Claims 81, 105, 124 and 136 under 35 USC §103 as being obvious in view of Shidlovsky. In view of the foregoing amendments, Applicants traverse this rejection.

Shidlovsky is directed to a CRT device with sodalite particles having an average size of 4 to 6 μm . It is disclosed that the particles are substantially spherical.

Independent Claim 80 has been amended to recite that the cathodoluminescent device includes a layer of phosphor particles selected from the group consisting of Y_2O_2S , ZnS , Zn_2SiO_4 , $SrGa_2S_4$ and Y_2SiO_5 . Shidlovsky does not disclose or suggest any of these phosphor compounds. Claims 81, 83, 84 and 93 depend upon Claim 80 and include all of the limitations thereof. Therefore, removal of this rejection with respect to Claims 80, 81, 83, 84 and 93 is requested.

Independent Claim 104 has been amended to recite that the display device includes a first layer of Zn_2SiO_4 phosphor particles. Shidlovsky does not disclose or suggest zinc silicate particles. Claims 105, 106 and 109 depend upon Claim 104 and include all of the limitations thereof. Therefore, removal of this rejection with respect to Claims 104-106 and 109 is requested.

Claim 124 has been amended to recite that the CRT display device includes phosphor particles selected from the group consisting of Y_2O_2S , ZnS , $SrGa_2S_4$ and Y_2SiO_5 . Therefore, removal of this rejection with respect to Claim 124 is requested. Claim 136 depends on Claim 124 and removal of this rejection with respect to Claim 136 is also requested.

Claim Rejections – Chadha in view of Matsuda

The Examiner has rejected Claims 80-82, 85, 92, 97-99, 103, 113-115, 120, 121, 124, 129, 130, 135 and 136 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,662,831 by Chadha in view of U.S. Patent No. 5,644,193 by Matsuda et al. In view of the foregoing amendments, Applicants traverse this rejection:

Chadha discloses yttria phosphor particles utilized in FED devices wherein the particles have an average size of about 1.1 μm . Matsuda et al. is directed to a method for making spherical phosphor particles.

Independent Claim 80 has been amended to recite that the phosphor particles are selected from the group consisting of Y_2O_2S , ZnS , Zn_2SiO_4 , $SrGa_2S_4$ and Y_2SiO_5 . Neither Chadha nor Matsuda et al. disclose or suggest these phosphor compounds. Claims 81 and 82 depend upon Claim 80 and include all of the limitations thereof. Claim 85 has been cancelled. Claim 92 also depends upon Claim 80. Therefore, removal of this rejection with respect to Claims 80-82, 85 and 92 is requested.

Independent Claim 97 has also been amended to recite that the display device includes phosphor particles selected from the group consisting of Zn_2SiO_4 , Y_2SiO_5 and SrGa_2S_4 . Neither Chadha nor Matsuda et al. disclose or suggest these phosphors. Claim 98 depends upon Claim 97 and includes all of the limitations thereof. Claim 99 has been cancelled. Claim 103 also depends upon Claim 97. Therefore, removal of this rejection with respect to Claim 97-99 and 103 is requested.

Independent Claim 113 has been amended to recite that the field emission display includes phosphor particles selected from the group consisting of yttrium silicate and strontium thiogallate. Neither Chadha nor Matsuda disclose or suggest these phosphor compounds. Claims 114 and 115 have been cancelled. Claims 120 and 121 depend upon Claim 113 and include all of the limitations thereof. Therefore, removal of this rejection with respect to Claims 113-115, 120 and 121 is requested.

Independent Claim 124 has been amended to recite that the CRT display device includes phosphor particles selected from the group consisting of $\text{Y}_2\text{O}_2\text{S}$, ZnS , SrGa_2S_4 and Y_2SiO_5 . Neither Chadha nor Matsuda discloses or suggests these phosphor compounds. Claims 129 and 130 have been cancelled. Claims 135 and 136 depend upon Claim 124 and include all of the limitations thereof. Therefore, removal of this rejection with respect to Claims 124, 129, 130, 135 and 136 is respectfully requested.

Claim Rejections – Sanjurjo et al.

The Examiner has rejected Claims 80, 82-89, 91-93, 95, 97, 101, 103, 104, 106, 109, 111 and 112 under 35 USC 102(e) as being anticipated by Sanjurjo et al. Further, the Examiner has rejected Claims 81, 98, 99, 105, 107, 108, 113-116, 118, 120, 121, 124-130 and 133-136 under 35 USC 103(a) as being obvious in view of Sanjurjo et al. Applicants traverse this rejection.

Sanjurjo et al. issued on March 21, 2000, based on an application having a filing date of December 5, 1997. The present application claims priority to U.S. Provisional Patent Application Serial No. 60/038,262, filed February 24, 1997. Therefore, Sanjurjo et al. is not an effective reference with respect to the present application. For the convenience of the Examiner, Applicants have attached a true copy of U.S. Provisional Patent Application Serial No. 60/038,262. Applicants submit that the claims under

consideration are fully supported by this provisional application. Particularly, the Examiner is referred to pages 28-29 for the disclosure of various phosphor compounds and pages 39-41 disclosing various applications of phosphor compounds, including cathodoluminescent devices.

In view of the foregoing, Applicants respectfully request removal of the rejections in view of Sanjurjo et al.


Double Patenting Rejections

The Examiner has rejected numerous claims under the judicially created doctrine of obviousness-type double patenting over Applicants co-pending applications and issued patents. Upon the indication of otherwise allowable subject matter, Applicants will submit the appropriate Terminal Disclaimer.

A petition for a three-month extension of time to respond to the outstanding Examiner's Action, along with the appropriate fee, accompanies this response. It is not believed that any additional fees are owed, however, any such additional fees can be charged to Deposit Account 50-1419.

Respectfully submitted,

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Revisions Showing Changes Made

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In the Specification:

Please amend the paragraph beginning at page 6, line 18, as follows:

[Fig. 35 shows] Figs. 35A-F show cross sections of various particle morphologies of some composite particles manufacturable according to the present invention.

Please amend the paragraph beginning at page 47, line 16, as follows:

Particularly preferred cathodoluminescent phosphors that are produced by spray-conversion according to the present invention include $Y_2O_3:Eu$, Y_2O_2S doped with Eu and/or Tb, ZnS doped with Au, Al, Cu or combinations thereof as well as ZnS doped with Ag or Cl, $SrGa_2S_4$ doped with Eu and/or Ce, $[Y_5(Ga,Al)_5O_{12}]$ $Y_3(Ga,Al)_5O_{12}$, i.e., $Y_3Ga_xAl_yO_{12}$ where x and y are 0 to 5.0 and x+y is 5 doped with Tb or Cr, $Zn_2SiO_4:Mn$ and Y_2SiO_5 doped with Tb or Ce.

Please amend the paragraph beginning at page 48, line 19, as follows:

Zinc sulfide can be produced from a precursor solution including thiourea and zinc nitrate. $[Y_5(Ga,Al)_5O_{12}]$ $Y_3(Ga,Al)_5O_{12}$ can advantageously be produced from a solution comprising all metal salts or can include particulate alumina.

Please amend the paragraph beginning at page 48, line 26, as follows:

The solution is preferably not saturated with the precursor to avoid precipitate formation in the liquid. The solution preferably includes, for example, sufficient precursor to yield from about 1 to 50 weight percent, such as from about 1 to 15 weight percent, of the phosphor compound. That is, the solution concentrations are measured based on the equivalent weight percent of the phosphor product. Water can be added to the liquid during processing to maintain the precursor concentration below a predetermined value. The final particle size of the phosphor particles is also influenced by the precursor concentration. Generally, lower precursor concentrations in the liquid feed will produce particles having a smaller average size.

Please amend the paragraph beginning at page 60, line 13, as follows:

The coating, either particulate or non-particulate, can also include a pigment or other material that alters the light characteristics of the phosphor. Red pigments can include compounds such as the iron oxides (Fe_2O_3), cadmium sulfide compounds ([CDs] CdS) or mercury sulfide compounds (HgS). Green or blue pigments include cobalt oxide (CoO), cobalt aluminate (CoAl_2O_4) or zinc oxide (ZnO). Pigment coatings are capable of absorbing selected wavelengths of light leaving the phosphor, thereby acting as a filter to improve the color contrast and purity. Further, a dielectric coating, either organic or inorganic, can be used to achieve the appropriate surface charge characteristics to carry out deposition processes such as electrostatic deposition.

Please amend the paragraph beginning at page 67, line 2 as follows:

Ink-jet printing is another method for depositing the phosphor powders in a predetermined pattern. The phosphor powder is dispersed in a liquid medium and dispensed onto a substrate using an ink jet printing head that is computer controlled to produce a pattern. The phosphor powders of the present invention having a small size, narrow size distribution and spherical morphology can be printed into a pattern having a high density and high resolution. Other deposition methods utilizing a phosphor powder dispersed in a liquid medium include micro-pen or syringe deposition, wherein the powders are dispersed such as by using a dispersing agent and applied to a substrate using a pen or syringe and are then allowed to dry.

Please amend the paragraph beginning at page 69, line 20 as follows:

A CRT display device is illustrated schematically in Fig. 37. The device 1002 includes 3 cathode ray tubes 1004, 1006 and 1008 located in the rear portion of the device.

The cathode ray tubes generate electrons, such as electron 1010. An applied voltage of at least about 5 kV, typically at least about 20 kV, such as 20 to 30 kV accelerates the electrons toward the display screen 1012. In a color CRT, the display screen is patterned with red (R), green (G) and blue (B) phosphors, as is illustrated in Fig. 38. Three colored phosphor pixels are grouped in close proximity, such as group 1014, to produce multicolor

images. Graphic output is created by selectively directing the electrons at the pixels on the display screen 1012 using, for example, electromagnets 1016. The electron beams are rastered in a left to right, top to bottom fashion to create a moving image. The electrons can also be filtered through an apertured metal mask to block electrons that are directed at the wrong phosphor.

Please amend the paragraph beginning at page 71, line 9, as follows:

CRT's typically operate at high voltages such as from about 20 kV to 30 kV. Phosphors used for CRT's should have high brightness and good chromaticity. Phosphors which are particularly useful in CRT devices include ZnS:Cu or Al or combinations thereof for green, ZnS:Ag, Au or Cl or combinations thereof for blue and [Y₂O₂S:Eu] Y₂O₂S with 0.01 to 10 atomic percent Eu, Tb or combinations thereof for red ZnS preferably includes from about 10⁻⁵ to 10⁻³ gram-atoms per mole of the activator ion. The phosphor particles can advantageously be coated in accordance with the present invention to prevent degradation of the host material or diffusion of activator ions. Silica or silicate coatings can also improve the rheological properties of the phosphor slurry. The particles can also include a pigment coating, such as particulate Fe₂O₃, to modify and enhance the properties of the emitted light.

Please amend the paragraph beginning at page 72, line 21, as follows:

The high electron voltages and small currents traditionally required to activate phosphors efficiently in a CRT device have hindered the development of flat panel displays. Phosphors for flat panel displays such as field emission displays must typically operate at a lower voltage, higher current density and higher efficiency than phosphors used in existing CRT devices. The low voltages used in such displays, such as [less] not greater than about 5 kV, result in an electron penetration depth in the range of several micrometers down to tens of nanometers, depending on the applied voltage. Thus, the control of the size and crystallinity of the phosphor particles is critical to device performance. If large or agglomerated powders are used, only a small fraction of the electrons will interact with the phosphor. Use of phosphor powders having a wide size

distribution can also lead to non-uniform pixels and sub-pixels, which will produce a blurred image.

Please amend the paragraph beginning at page 74, line 2 as follows:

Phosphors which are particularly useful for FED devices include thiogallates such as $\text{SrGa}_2\text{S}_4\text{:Eu}$ for green, $\text{SrGa}_2\text{S}_4\text{:Ce}$ for blue and ZnS:Ag or Cl or combinations thereof for blue. $\text{Y}_2\text{O}_3\text{:Eu}$ can be used for red. ZnS:Ag or Cu or combinations thereof can also be used for higher voltage FED devices. $[\text{Y}_2\text{Si}_5\text{:Tb}]$ $\text{Y}_2\text{SiO}_5\text{:Tb}$ or Eu can also be useful. For use in FED devices, these phosphors are preferably coated, such as with a very thin metal oxide coating, since the high electron beam current densities can cause breakdown and dissociation of the sulfur-containing phosphor host material. Dielectric coatings such as SiO_2 and Al_2O_3 can be used. Further, semiconducting coatings such as SnO or In_2O_3 can be particularly advantageous to absorb secondary electrons.

In the Claims:

80. (Amended) A cathodoluminescent device, comprising:
- a) an excitation source; and
 - b) at least a first layer of cathodoluminescent phosphor particles selected from the group consisting of $\text{Y}_2\text{O}_2\text{S}$, ZnS , Zn_2SiO_4 , SrGa_2S_4 and Y_2SiO_5 that are adapted to be stimulated by said excitation source, wherein said phosphor particles have a weight average particle size of from about 0.1 μm to about 10 μm , a substantially spherical morphology and wherein at least about 80 weight percent of said particles are not larger than about two times said average particle size.
97. (Amended) A cathodoluminescent display device, comprising:
- a) an excitation source having an excitation potential of not greater than about 5 kV; and
 - b) at least a first layer of cathodoluminescent phosphor particles selected from the group consisting of Zn_2SiO_4 , Y_2SiO_5 and SrGa_2S_4 that are adapted to be stimulated by said excitation source, wherein said phosphor particles have a weight average particle size of from about 0.1 μm to about 10 μm , a substantially spherical morphology and wherein at least about 80 weight percent of said particles are not larger than about two times said average particle size.
104. (Amended) A cathodoluminescent display device, comprising:
- a) an excitation source having an excitation potential of at least about 20 kV; and
 - b) at least a first layer [of] comprising Zn_2SiO_4 cathodoluminescent phosphor particles adapted to be stimulated by said excitation source, wherein said phosphor particles have a weight average particle size of from about 0.1 μm to about 10 μm , a substantially spherical morphology and wherein at least about 80 weight percent of said particles are not larger than about two times said average particle size.

113. (Amended) A field emission display, comprising:
- (a) a back plate portion comprising a plurality of electron tip emitters; and
 - (b) a transparent front plate portion comprising a layer of phosphor powder comprising substantially spherical cathodoluminescent phosphor particles selected from the group consisting of Y_2SiO_5 and $SrGa_2S_4$, wherein said phosphor particles have a weight average particle size of [not greater than] from about 0.1 μm to about 5 μm and a particle size distribution wherein at least about 80 weight percent of said particles are not larger than twice said average particle size.
124. (Amended) A CRT display device, comprising:
- (a) an excitation source comprising an electron emitter; and
 - (b) a transparent front plate portion comprising a layer of phosphor powder comprising substantially spherical cathodoluminescent phosphor particles selected from the group consisting of Y_2O_2S , ZnS , $SrGa_2S_4$ and Y_2SiO_5 , wherein said phosphor particles have a weight average particle size of [not greater than] from about 0.1 μm to about 5 μm and a particle size distribution wherein at least about 80 weight percent of said particles are not larger than twice said average particle size.
138. (Amended) A projection CRT display device, comprising:
- a) a cathodoluminescent excitation source;
 - b) a display screen; and
 - c) a phosphor layer disposed between said excitation source and said display screen, wherein said phosphor layer comprises substantially spherical cathodoluminescent phosphor particles selected from the group consisting of Y_2O_3 , Y_2O_2S and Zn_2SiO_4 , wherein said phosphor particles have a weight average particle size of [not greater than] from about 0.1 μm to about 5 μm and a particle size distribution wherein at least about 80 weight percent of said particles are not larger than twice said average particle size.